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DESCRIPTION OF GANZ DIESEL-ELECTRIC TRAIN DELIVERED TO THE USSR

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/Figures referred to are appended./

The Ganz Villamossagi Vallalat (Ganz Electric Enterprises) sold many diesel motor vehicles before the liberation. At that time, however, the vehicles produced had only 200-300 horsepower motors, and therefore were constructed with a variable transmission. After the war, the USSR began to purchase Hungarian goods; however, for Soviet requirements, the old units with their comparatively low power were inadequate. Despite the fact that the Ganz Villamossagi Vallalat had not produced any modern diesel-electric vehicles before the war, it had to choose diesel-electric power, even though its design engineers had little experience in that field. The USSR wanted a self-contained train for 180-200 passengers which would satisfy all modern requirements, reach a maximum speed of 105 kilometers per hour on level ground, and usually would not travel on a grade exceeding one percent. The inside temperature was to be maintained at 20-22 degrees centigrade, although the outdoor temperature might vary between +30 and -35 degrees centigrade.

The diesel train, which is a self-contained unit, consists of two, five-axle locomotives and four four-axle coaches with automatic coupling and bumper equipment. The bodies and the rotating parts are completely welded.

The train, which is about 160 meters long, includes 190 berths, two baggage compartments for a total of 5,000 kilograms of mail and baggage, an electric kitchen, a bar, a restaurant, and heating and air-conditioning apparatus separately operated in each car. There are four motors in the train, two of which produce 600 horsepower each and are used for traction only, and two 220-horsepower motors which supply the power for auxiliary machinery and appliances. The total output,

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consequently, is 1,640 horsepower. The train weighs approximately 390 tons at maximum load. There are two driving axles per locomotive and the total load on these axles is 76 tons. The train travels at 105 kilometers per hour and attains a maximum speed of 125-130 kilometer per hour on level ground in calm weather.

The train is controlled by a switch. After the switch has been set, the train speed is regulated by an automatic regulator.

The main motor for each locomotive consists of a four-stroke V-16 Ganz-Jendrassik-type diesel-oil motor, which has an output of 600 horsepower at 1,100 revolutions per minute, and of a direct-coupled, single-bearing, standard output generator with compensator and starter winding, producing approximately 720 kilowatts. The generator is self-excited, but there is also a small outside exciter. The power for the latter is supplied by a 50-volt, 200-ampere-hour battery. The diesel motor receives its fuel injection from a pump through a spring-loaded injection nozzle. As required by the usual starter system, the motor has drive shafts. The motor is started by the batteries, which also supply the power for lighting. Under regular operating conditions, these comparatively small-capacity batteries will start the motor without any assistance. Under unusual conditions, with a very cold and thick lubricant, or if the batteries are partially exhausted, the generator is used to assist starting. For this purpose, the generator is a little oversized by the increase in weight and cost is small compared to that which would be required for batteries with a larger capacity.

The speed of the diesel motor during operation is regulated by the electric control apparatus. For idling, warming up, and starting the train there is a three-spring centrifugal governor which sets the motor at 550, 850 and 1,150 revolutions per minute. To prevent major damage in the case of lubrication failure, the diesel motor is provided with piston oil pressure control equipment (operating on pressure difference) which stops the motor in case of inadequate lubrication.

The two journal bearing electric motors, which are of standard construction, very sturdy, and externally cooled, receive their power from the main generator through the main switched and direction controls. The journal bearings are lubricated by hemp pads which are protected against dust. Since the USSR did not intend to use the locomotives on mountain tracks and since the weight of the train is constant, it was found practical to run the motors permanently in parallel without providing for field reduction, whereby utmost simplicity of the equipment was achieved.

The train's automatic control equipment has the following functions (see Figure 1).

It adjusts the charge on the diesel motor corresponding to the "MSz" /speed control/ position of the switch and at the same time sets the rheostats for starting power and operating speed control ("IA" and "UF").

It speeds up the train, with the starting power corresponding to the position of the switch, keeping the starting traction at a constant value as long as the specified diesel motor output will permit. After that, with steadily decreasing tractive power, it continues to speed up the train until the required tractive power reaches a perfect balance with the determined output.

If the diesel motor, because of some partial breakdown, cannot put out its full power, the control equipment will keep it at the determined speed by reducing the power output to the necessary degree, and thus protect the motor against eventual overloading which would reduce its speed and impair its lubrication.

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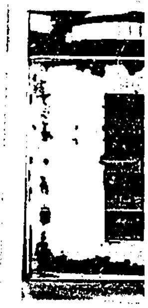

The following is a description of the instruments necessary for these functions.

The standard-type master switch for direction control and speed regulation is equipped with a lever, control instruments, and control lights indicating the operation of the engine.

The charge setting and regulating apparatus consists of an electropneumatic piston combination, a three-section resistor system with electromotor control, and a so-called dynamic relay (see Figure 2).

The dynamic relay "DR" is actually an externally excited balanced circu. : voltmeter with very high inertia which, if forced out of its neutral position, acts on a carbon disk resistor. The high-inertia voltmeter is coupled to two moving contact levers. Whenever the position of the two levers is unequal, the voltmeter swings out of its central position and compresses the carbon disk resistor, which causes the auxiliary motor "TM" to run until the two moving contacts are again brought into equal positions. When this is the case, the voltmeter ceases to indicate a difference in voltage and, reassuming its neutral position, releases the carbon disks, thus switching off the auxiliary motor.

The main parts of the automatic starter and generator control are the resistors ("SZ" and "E") fitted into the externally-and self-excited circuits of the main generator, the pneumatohydraulic servomotor ("SZM"), the magnetic oil inlet valve ("MO") and the astatic revolving magnets ("AM"). (See Figure 1.)

Other parts of the main machinery, such as contacts, direction switch, relays, etc., are of a standard type. The power for auxiliary machinery and appliances is supplied by three-phase 380-volt generators which are directly coupled with two 220-horsepower 1,000-revolution-per-minute diesel motors.

The trains travel under their own power from the plant to Moscow. Up to the border station the train is mounted on a complete set of standard-gauge rolling gear, which is then replaced by broad-gauge equipment.

Since railroad lines in Hungary, because of comparatively small grades on main lines and short distances between terminals, are not suitable for load tests of trains, the actual delivery tests are made in the USSR. The climbing capacity and hourly performance were tested on the Uzhok and Beskid lines. After these load tests, the train arrived at Moscow via the Chop-L'vov-Kiev-Kursk-Moscow line. The speed tests for the first trains were held on the experimental circular track of the Soviet Ministry of Transportation, 50 kilometers from Moscow. This experimental track is a closed circuit with a 2-kilometer diameter and an excellent roadbed. All self-propelled rolling stock of the Soviet railroads is subjected to extensive tests of tractive force and durability on this track. Near the circular track there is an experimental center equipped with dynamometer cars. For tests of electric vehicles, the circular track has been electrified and provided with direct-current substations which supply the necessary power. On this track the train was subjected to acceleration and load tests.

During the load tests, four-axle, 80-ton cars were coupled behind the train as a substitute for grade and curve resistance. The maximum load hauled was five cars, or 400 tons. After these tractive force tests the train was operated at 100 kilometers per hour for 3 hours, and then, after a 15-minute stop and check, was run again for 2 hours. During the test runs, the operation and synchronization of the train's electric equipment was tested by means of recording instruments by engineers of the Soviet Institute for Railroad Science /possibly the All-Union Scientific Research Institute of Railroad Transportation, or the Central Scientific Research Institute of the Ministry of Transportation USSR/. After the favorable results gained on the circular track, the train was tested with an unusually short time schedule on the Moscow-Leningrad main line, which

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is about 650 kilometers long. The time required for the test run from Moscow to Leningrad was found to be 7 hours and 20 minutes, including a 30-minute stop on the way, which corresponds to an average traveling speed of 95 kilometers per hour, as compared with the present 12-hour schedule of the Krasnaya Strela express train. The train kept its schedule to the minute, and ran at a speed of about 115-120 kilometers per hour over long sections of the road. According to statements made by Soviet railroad men, that run had never before been covered by rolling stock in such a short time. Since this spring, the trains have been on a regular schedule on the Moscow-Leningrad line. Their time, including two stops on the way, is 10 hours.

/Appended figures follow./

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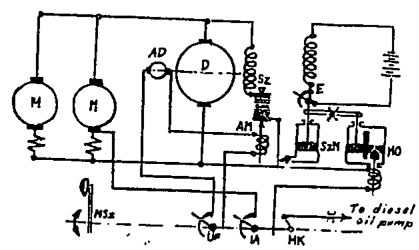

Figure 1

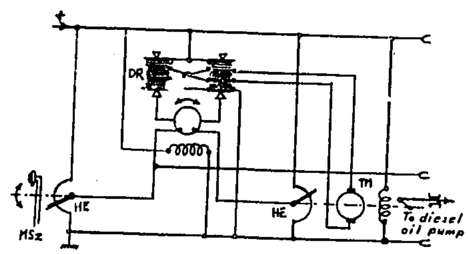

Figure 2

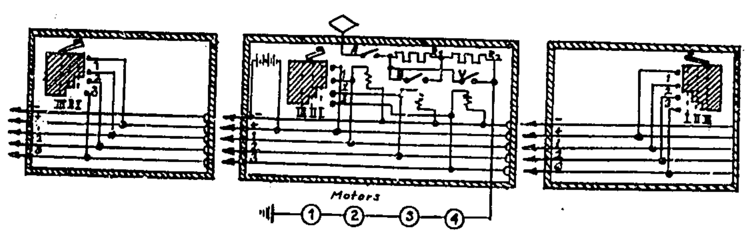

Figure 3

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